The Use of High-Powered, Intermittently-Pulsed IR Laser Emitters in Conjunction with Passive Sonar to Create Virtual Hydro-Thermal Lenses for the Reduction of Acoustic Noise, Facilitated by A.I. Sonalysis of Data Within 1/10th Second Noise-Free Windows

10 October 2022
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Introduction

When we want to gather optical data, we have a tool called a lens to help us to accomplish the task. We take them for granted, but without lenses, we would not be able to capture useful visual information using photography.

Lenses enable light to be either captured or discarded, ultimately, according to the angle at which the light strikes the lens. Objects that are very distant give off light that tends to come, directionally, from a very narrow range of angles, all of them near exact center. The filtering (by scattering) of all light coming from off-center angles helps to emphasize that portion of the captured light that strikes the lens head-on by making sure that only this light reaches the photo-detector.

In the area of passive sonar, there is a real need for a mechanism that does for passive sonar what a lens does for a camera. While active sonar can use time-of-flight to assess range, passive sonar has to guess at range by making assumptions about how noisy another submarine or ship was when a sound was generated and how far the sound could be expected to carry under the present conditions including water temperature, the presence or absence of a thermal gradient between the sub employing passive sonar and the noise source to be analyzed, and the speed and relative direction of any ocean currents.

Abstract

Even more important than getting an exact range calculation on a ship at a distance is making positive identification of the ship's class as early as possible. The ability to filter out sounds that come from off-center directions and from nearby sources would greatly enhance the usefulness of existing passive sonar.

Inspired by the fact that colder, more dense waters can reflect sounds in an upward direction like an echo from a brick wall, it occurred to me that pockets of warm water would have a different and unique effect on the small scale upon sound waves in the water.

The reflection of sound by cold waters at lower depths is caused by the relatively high density of the cold water as opposed to the low density of the water moving toward it. Like a ball bouncing on pavement, sound is deflected by colder masses of water. This is a well-known dynamic that submariners use to their advantage whenever possible.

What has not been explored is how heating water may be used to turn that water into a lens for sound, achieving for passive sonar what a lens does for traditional optics.

I propose that a modern passive sonar array combined with an A.I.-based sonalysis system may be effectively employed to allow sound to be lensed so as to scatter undesired sounds away from the center of a given hydrophone to enable the system to focus on only distant sounds that pass through the exact center of the perimeter of each individual detector.

I propose that each directionally-oriented component of a modern sonar mechanism can be ringed with a high-energy, focused IR laser designed to heat the water around the periphery of detector zones while keeping the water in the center at parity with the ambient ocean temperature. As we know, water that is equal with the temperature of the water from which a sound was emitted will conduct sound normally. Substantially heated water, however, has a lower density. I propose, therefore, that when these sound waves enter the selectively heated areas that the heated water will scatter any sound not originating from maximal distance from the detector and will act to focus sound coming from the desired direction (and therefore distance.)

To prevent the entire body of water immediately in front of the detector from being heated, the IR laser emitter would be pulsed for about a tenth of a second at a time with five second intervals in between pulses to allow the temperature to equalize.

During the window within which the periphery of detector zones have their water heated, the noise from non-target areas falls away, if only for a moment. This moment is not long enough for a human sonalyst to make sense of the data, however, a series of 1/10th second observations could be stitched together by an A.I. to make a high-accuracy assessment of the data. A series of 1/10th second snapshots of noiseless audio would provide high-quality passive sonar telemetry that would confer a marked tactical advantage to any submarine employing the technology.

This new type of passive sonar would resemble to a certain degree the crystal ball dropped each New Year's Eve in Times Square with blinding light emanating from around the edges of each facet on the sphere. In this case, however, the light would not fall within the visible spectrum and detection of the light by an enemy would not be a concern given the limited range over which light could propagate at depth under most conditions and the fact that even without the addition of this feature, existing systems work well enough to exclude the possibility of a nearby submarine capable of detecting bright light sources (assuming any subs are equipped to check for such submarine emissions in the first place) before this feature is activated.

Conclusion

Such an IR emitter would be a finely-tuned, high-powered system that comes as close as possible to boiling the water (this would generate bubbles and would not be desired) as possible without actually doing so. As the gradient of the heated water shifts over a portion of second, the same portions of the

detector that emit the light can take measurements of the temperature of the water in order to inform the computer as to how to interpret the received data to compute ranging information.